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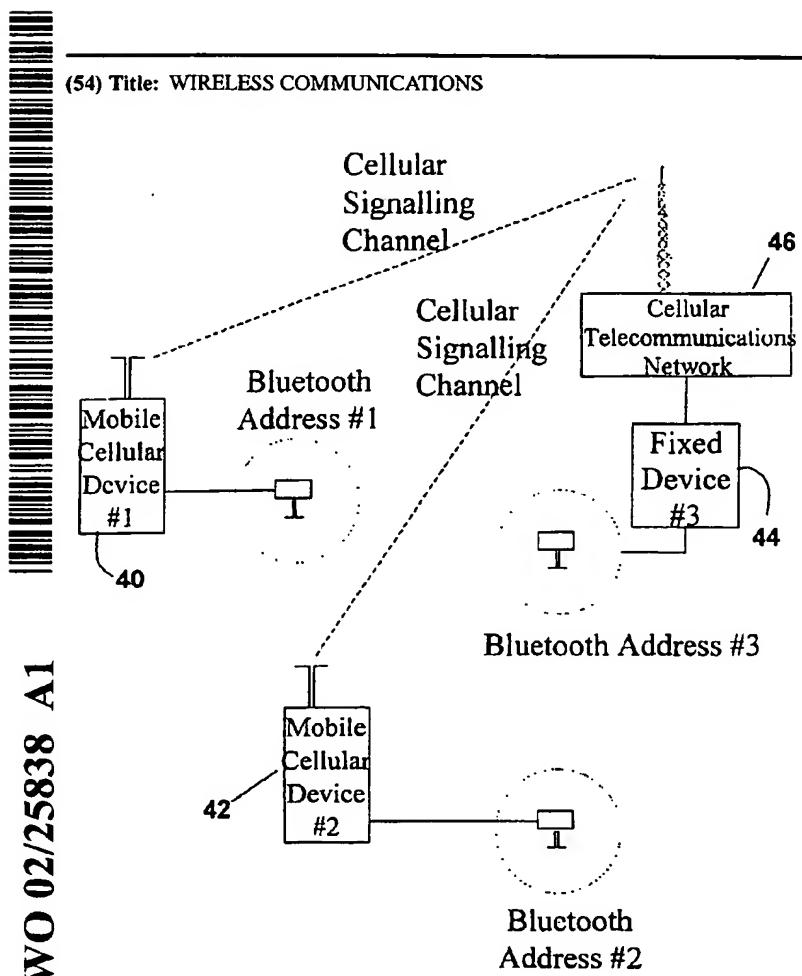
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(54) Title: WIRELESS COMMUNICATIONS



(57) Abstract: A method of establishing a Bluetooth piconet between a first device and a second device, including storing the address of the second device in the first device without executing an inquiry scan, and transmitting a page scan from the first device using said address to establish a piconet with the second device. A number of addresses may be stored in the first device, and respective page scans for these addresses may be transmitted to establish a piconet with other devices. Once a device responds to a page scan, the corresponding address is no longer paged until the device leaves the piconet. A single address may be reused by a number of devices at different locations. The addresses may be downloaded to the first device from a telecommunications network.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

WIRELESS COMMUNICATIONS

- 5 The present invention relates to a method for establishing wireless communications between devices, and in particular to a Bluetooth piconet and a method of establishing a piconet between devices.

Recent advances in technology are encouraging the adoption of wireless communications
10 devices for a wide variety of applications. In particular, a short-range radio frequency (RF) technology known as Bluetooth holds much promise for enabling unassisted communication between low cost, portable devices. Bluetooth devices communicate in a master-slave fashion to form a localised network called a "piconet". In order to form a piconet with a master device, a slave device needs two pieces of information: the master's address, and the value of its internal clock offset. It obtains this information by a two step
15 method. First, to find Bluetooth devices within range, a master device transmits an inquiry scan using a broadcast address. In response to the inquiry, each listening device within range transmits its address back to the master. This inquiry phase is quite slow and can take 10 seconds or longer. Once the master has a slave address, it can perform a page scan
20 of a slave device, whereby the master transmits its address and clock offset to the slave device, enabling it to connect to the slave device and thereby establish a piconet with it. The page scan is much faster than the inquiry scan and typically takes only ~ 1 second to complete.

- 25 One of the limitations of Bluetooth is the relatively long time required to establish a piconet between devices. This time may be prohibitive for some applications, such as push-data services. Furthermore, Bluetooth does not provide a network management layer. It is desired to address these shortcomings, or at least provide a useful alternative.
- 30 In accordance with the present invention, there is provided a method of establishing wireless communications, including:

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storing at least one address for a wireless communications device in a mobile wireless communications device without executing a scan for devices within range of the mobile device; and

- 5 executing a link request from said mobile device using the address to establish a wireless communications link with a second wireless communications device.

The present invention also provides a method of establishing a Bluetooth piconet between a first device and a second device including:

- 10 storing the address of said second device in said first device without executing an inquiry scan; and

executing a page scan from said first device using said address to establish a piconet with said second device.

- 15 Advantageously, a number of addresses may be stored in said first device so that a number of other devices may be paged by said first device in order to establish a piconet between said first device and said other devices.

- 20 Preferably, the master device includes a plurality of Bluetooth device addresses, and the method includes executing respective page scans on the basis of the addresses until a slave device responds. The scans preferably continue for unanswered addresses or for answered addresses for devices out of range.

Advantageously, the addresses may be downloaded to the mobile device from a telecommunications network. Encryption keys may also be downloaded.

25

Advantageously, the signalling channel of a telecommunications network may be used to manage Bluetooth devices by using the Bluetooth Host Control Interface.

The present invention also provides a Bluetooth network, including:

- 30 at least one fixed Bluetooth device having an address; and.

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at least one mobile device storing said address and executing a page scan on the basis of the address to establish a link with the fixed device without executing an inquiry scan.

- 5 The address or addresses stored in the mobile device may be reusable, such that page scans are executed using the address whenever a link is not established with a device having the address. The address may be downloaded or substituted using a signalling channel of a telecommunications network adapted to communicate with the mobile device.
- 10 The present invention also provides a method of establishing a Bluetooth piconet between a first device and other devices, including:
 - storing addresses of said other devices in said first device without executing an inquiry scan; and
 - executing respective page scans from said first device using said addresses to establish
- 15 a piconet with said other devices.

The present invention also provides a method of establishing a Bluetooth piconet between a first device and a second device, including:

- storing at least two addresses in said first device without executing an inquiry scan;
- 20 executing respective page scans from said first device using said addresses until said second device answers one of said scans; and
- establishing a piconet with said second device.

The present invention also provides a method of establishing a Bluetooth piconet between a first device and at least one other device, including:

- storing at least one address of said at least one other device in said first device without executing an inquiry scan; and
- executing respective page scans from said first device using said at least one address to establish a piconet with said at least one other device.

- 30 The present invention also provides a Bluetooth network, including:
 - at least one fixed Bluetooth device having an address; and

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at least one mobile device having storage means for storing said address without transmitting an inquiry scan; and transmitting means for transmitting a page scan on the basis of the stored address to establish a link with the fixed device.

- 5 The present invention also provides a Bluetooth network, including:
at least one fixed Bluetooth device having a first address; and
at least one mobile device having storage means for storing at least said first address without transmitting an inquiry scan, and transmitting means for transmitting respective page scans on the basis of the at least said first address to establish a link with the fixed
10 device.

The present invention also provides a Bluetooth network, including :
at least one fixed Bluetooth device having a first address;
at least one mobile device having storage means, transmitting means, receiving means and
15 control means;
and wherein the storage means stores said first address and at least one other address, and the control means is operable to cause the transmitting means to transmit a page scan for each address stored in the storage means;
and wherein the control means is operable to establish a link with the fixed device when
20 the receiving means receives from said fixed device a response to a page scan for said first address.

- 25 Preferably, the address stored in the storage means is reusable, such that a page scan is executed using a stored address whenever a link is not established with a device having that address.

- The present invention also provides a method of establishing wireless communications using a protocol which uses a scan to determine an address of a device within range of a mobile device, including:
30 storing at least one address for a wireless communications device in a mobile wireless communications device without executing a scan for devices within range of the mobile device; and

- 5 -

executing a link request from said mobile device using the address to establish a wireless communications link with a second wireless communications device.

Preferred embodiments of the present invention are hereinafter described, by way of 5 example only, with reference to the accompanying drawings, wherein:

Figure 1 is a schematic diagram of the inquiry scan phase of a Bluetooth piconet;
Figure 2 is a schematic diagram of the page scan phase of a Bluetooth piconet;

10 Figure 3 is a block diagram of a preferred embodiment of a wireless network; and
Figure 4 is a block diagram of a preferred embodiment of a wireless network using
the signalling channel of a cellular network.

Bluetooth devices are well known and each Bluetooth device normally includes a number 15 of hardware components, including a receiver, a transmitter, storage memory and a central processing unit. Further information about Bluetooth devices and the hardware, software and communications protocols of the devices is provided on the official Bluetooth web site at <http://www.bluetooth.com>, including technical specifications for the devices. It is therefore unnecessary to describe in detail the hardware configurations of Bluetooth 20 devices.

Bluetooth devices communicate over a spread frequency spectrum using frequency hopping over 79 frequency channels with a 1 MHz spacing. Communication takes place by transmitting and receiving data while hopping through these channels in a pseudo-random 25 order. In order for two Bluetooth devices to communicate in this manner, they must hop through the frequency spectrum in the same order and in phase. Each Bluetooth device is assigned a unique 48-bit IEEE 802 physical layer address which can be used to generate a particular hopping pattern. The current position within the hopping pattern is determined from a clock offset value and the physical layer address.

30 When Bluetooth devices are connected in the above manner, they are said to have formed a piconet. The device whose hopping pattern and clock offset are used in a piconet is called

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the master device. The prior art method for forming a piconet begins when a Bluetooth device ('device A') 2 broadcasts an inquiry scan (using a reserved inquiry address) to locate available Bluetooth devices within transmission range, as shown in Figure 1. A second device ('device B') 4 can respond to the inquiry by sending its address ('address 5 B') 10 and its clock offset ('clock B') 12 to the first device 2.

To complete the connection, as shown in Figure 2, the first device 2 issues a page scan to the second device 4 and sends its address 6 and clock offset 8. The second device 4 loads the received address 6 and clock offset 8 and enters into a connection state with the first 10 device 2. The first device 2 is now said to be the master, and the second device 4 is said to be the slave.

The page scan phase of establishing communication is approximately one order of magnitude faster than the initial inquiry phase that is used to determine the addresses of 15 Bluetooth devices within range. Thus the total time taken to form a piconet is mostly the time taken to perform the inquiry scan phase.

A piconet can be formed rapidly if the master device already knows the Bluetooth addresses of the devices to connect to, so that the slow inquiry phase is not required. In one 20 embodiment of the present invention, Bluetooth addresses may be used by more than one device, provided that no master device is simultaneously within range of more than one device using a single address at the time that the master device transmits a page scan to that address. This can be ensured by assigning these addresses to immobile or fixed devices. Mobile devices acting as masters can be preloaded with a small set of these 25 known, reused addresses, so that the mobile devices only have to perform page scans in order for the fixed devices to join or form a piconet with the mobile device.

Figure 3 shows a network with four fixed Bluetooth devices or 'nodes' 21 to 24. The first node 21 and the third node 23 are out of communication range with each other, and both 30 nodes have been assigned an identical, first address. Similarly, the second node 22 and the

fourth node 24 are out of communication range with each other, and both nodes have been assigned an identical, second address.

A mobile Bluetooth device 26 with a third Bluetooth address is preloaded with the first 5 address used by the first and third nodes 21, 23, and also the second address used by the second and fourth nodes 22, 24. The mobile device 26 attempts to communicate with the fixed nodes 21 to 24 by repeatedly performing page scans on the first address and the second address. When the mobile device 26 approaches the first node 21 and comes 10 within communication range, the first node 21 receives the page scan directed to the first address, loads the address and clock offset of the mobile device 26, and thereby becomes a slave to the mobile master device 26.

Once the first address is used in the piconet, the mobile device 26 no longer issues page 15 scans to that address. However, page scans continue to be issued to the second address. As the mobile device 26 moves away from the first node 21 towards the second node 22, the second node 22 comes within communication range. The second node 22 receives the page scan directed to the second address and joins the piconet by becoming a second slave to the master device 26. The master device 26 no longer issues any page requests because 20 all the stored addresses are in use by the piconet. Eventually, the master device 26 moves so far away from the first node 21 that communication with the first node 21 is lost. The first address is no longer used by the piconet, and the master device 26 resumes issuing page requests to the first address. Alternatively, the master device 26 may be configured to issue page requests only when the RF signal of the piconet becomes weak. This can occur 25 when the value of the signal strength indicator of the master device 26 drops below a threshold signal strength, or by the magnitude of the bit error rate (BER).

When the third node 23 is within range, the page scan for the first address is received by 30 the third node 23, which thereby joins the piconet. Hence the same first address is used to communicate between the mobile device 26 and the first node 21 when they are within communication range, and between the mobile device 26 and the third node 23 when they are within communication range. There is no conflict because, in this embodiment, the

mobile device 26 is never simultaneously within communication range of these immobile nodes. The same argument applies to the second address. More generally, a single address can be used by an arbitrarily large number of devices, provided that any master device (which does not use the reused address as its own address) is never simultaneously within 5 range of two such devices when it issues a page scan to the reused address. This does not necessarily require the devices sharing the address to be fixed in space, but places restrictions on their relative locations. For convenience, they are referred to as fixed nodes.

By using two shared or reused addresses (as described above), an arbitrarily large number 10 of devices can communicate with a mobile master device (which does not use either of the two reused addresses) in such a way as to allow the mobile master device to always be in communication with at least one other node. Of course, if the fixed nodes are very far apart, the communication is not continuous, and a single address can be used for all fixed nodes.

15

The network of Figure 3 can be implemented by positioning the fixed devices 21 to 24 accordingly and adjusting the control software of the master and slave devices 21 to 26 to have the unique and reused addresses, and execute the scans, as described above.

20 Another embodiment of the present invention can be used if the Bluetooth devices are also able to communicate with a cellular communications network 46, as shown in Figure 4. The cellular network, being a CDMA, GSM or other wide area radio frequency communications network, uses signalling channels to configure and manage cellular communications devices, such as mobile phones. In this embodiment, these signalling 25 channels are also used to manage Bluetooth piconets. Indeed, a signalling channel may be used to manage all aspects of the Bluetooth protocol stack via the Host Control Interface (HCI). A first mobile Bluetooth device 40 and a second mobile Bluetooth device 42 are both connected to the cellular communications network 46. The first device 40 has a first address ADDR1 and the second device has address ADDR2. A third, immobile or fixed 30 Bluetooth device 44 with address ADDR3 is also connected to a communications network,

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such as the cellular telecommunications network 46. All three devices are within range of each other for Bluetooth communications.

The approximate physical location of the mobile devices 40, 42 is known to the cellular 5 network 46 via the network's usual localisation capabilities. Even if a device is not capable of using the cellular network 46, but has recently connected to another device, such as the fixed device 44, it is assumed to be within range of the latter device. To connect the first device 40 to the second device 42 and the fixed device 44, the signalling channel of the cellular network 46 is used to change the properties of the Bluetooth 10 protocol stack of the first device 40. The addresses ADDR2 and ADDR3 of the second 42 and third 44 devices are transmitted to the first device 40 using the signalling channel. If secure, encrypted communication is desired, then encryption keys or PINs are transmitted via the signalling channel to each of the three devices. This of course requires all three devices 40 to 44 to be connected to the cellular network 46. The signalling channel is then 15 used to instruct the second device 42 and the third device 44 to allow connections from the first device 40. An instruction is sent via the signalling channel to the first device 40, causing it to perform page scans to the second device 42 and the third device 44. A secure piconet has now been remotely and rapidly established between selected devices, without the need to perform inquiry scans. Once a Bluetooth connection is made, the 20 telecommunications provider can then automatically initiate programs to be executed on a mobile device, according to preferences previously made by the user of the mobile device.

In comparison to the first embodiment, the use of signalling channels to manage connections avoids the need to repeatedly perform energy consuming page scans.

25

To implement control of the Bluetooth devices using the cellular network, configuration changes are made to the network software as well as to the devices 40 to 44.

Many modifications will be apparent to those skilled in the art without departing from the 30 scope of the present invention as herein described with reference to the accompanying drawings.

CLAIMS:

1. A method of establishing wireless communications, including:
 - 5 storing at least one address for a wireless communications device in a mobile wireless communications device without executing a scan for devices within range of the mobile device; and
 - executing a link request from said mobile device using the address to establish a wireless communications link with a second wireless communications device.
- 10 2. A method of establishing a Bluetooth piconet between a first device and a second device, including:
 - storing the address of said second device in said first device without executing an inquiry scan; and
 - executing a page scan from said first device using said address to establish a piconet with said second device.
- 15 3. A method of establishing a Bluetooth piconet between a first device and other devices, including:
 - 20 storing addresses of said other devices in said first device without executing an inquiry scan; and
 - executing respective page scans from said first device using said addresses to establish a piconet with said other devices.
- 25 4. A method of establishing a Bluetooth piconet between a first device and a second device, including:
 - 25 storing at least two addresses in said first device without executing an inquiry scan; executing respective page scans from said first device using said addresses until said second device answers one of said scans; and
 - establishing a piconet with said second device.
- 30 5. A method as claimed in claim 4, including executing respective page scans from said first device using unanswered addresses and answered addresses of devices out of communication range with said first device.

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6. A method as claimed in claim 4, including executing respective page scans from said first device using addresses not in use by said piconet.
- 5 7. A method as claimed in claim 4, including executing respective page scans from said first device using said addresses based on a measure of the piconet signal strength.
8. A method of establishing a Bluetooth piconet between a first device and at least one other device, including:
 - 10 storing at least one address of said at least one other device in said first device without executing an inquiry scan; and
 - executing respective page scans from said first device using said at least one address to establish a piconet with said at least one other device.
- 15 9. A method as claimed in any one of claims 2, 4, 5, 6 and 7, wherein said first device is a mobile device, and said second device is a fixed device.
10. A method as claimed in any one of claims 3 to 7, including downloading the addresses to the first device from a telecommunications network.
- 20 11. A method as claimed in any one of the preceding claims, including downloading encryption keys to said devices from a telecommunications network.
12. A method as claimed in any one of claims 3 to 9, wherein said page scans are executed in response to an instruction from a telecommunications network.
- 25 13. A method as claimed in any one of claims 3 to 9, including transmitting instructions from a telecommunications network to said second device to allow connections from said first device.

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14. A method as claimed in any one of claims 3 to 9, including transmitting instructions from a telecommunications network to said second device to execute programs on said first devices.
- 5 15. A method as claimed in any one of the preceding claims, including managing said devices using a signalling channel of a telecommunications network and a host control interface.
16. A Bluetooth network, including:
 - 10 at least one fixed Bluetooth device having an address; and at least one mobile device having storage means for storing said address without transmitting an inquiry scan, and transmitting means for transmitting a page scan on the basis of the stored address to establish a link with the fixed device.
 - 15 17. A Bluetooth network, including:
 - at least one fixed Bluetooth device having a first address; and at least one mobile device having storage means for storing at least said first address without transmitting an inquiry scan, and transmitting means for transmitting respective page scans on the basis of the at least said first address to establish a link 20 with the fixed device.
 18. A Bluetooth network, including :
 - at least one fixed Bluetooth device having a first address;
 - 25 at least one mobile device having storage means, transmitting means, receiving means and control means;
 - and wherein the storage means stores said first address and at least one other address, and the control means is operable to cause the transmitting means to transmit a page scan for each address stored in the storage means;

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and wherein the control means is operable to establish a link with the fixed device when the receiving means receives from said fixed device a response to a page scan for said first address.

- 5 19. A Bluetooth network as claimed in any one of claims 16 to 18, wherein the address stored in the storage means is reusable, such that a page scan is executed using a stored address whenever a link is not established with a device having that address.
- 10 20. A Bluetooth network as claimed in any one of claims 16 to 18, wherein the address is downloaded using a signalling channel of a telecommunications network adapted to communicate with the mobile device.
21. A method as claimed in claim 7, wherein said measure includes the bit error rate.
- 15 22. A method as claimed in claim 7, wherein said measure includes a signal strength indicator value.
- 20 23. A method of establishing wireless communications using a protocol which uses a scan to determine an address of a device within range of a mobile device, including:
 - storing at least one address for a wireless communications device in a mobile wireless communications device without executing a scan for devices within range of the mobile device; and
 - executing a link request from said mobile device using the address to establish a wireless communications link with a second wireless communications device.

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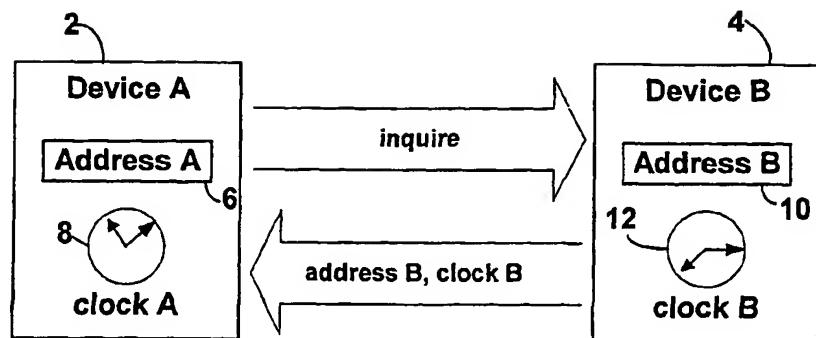


Figure 1

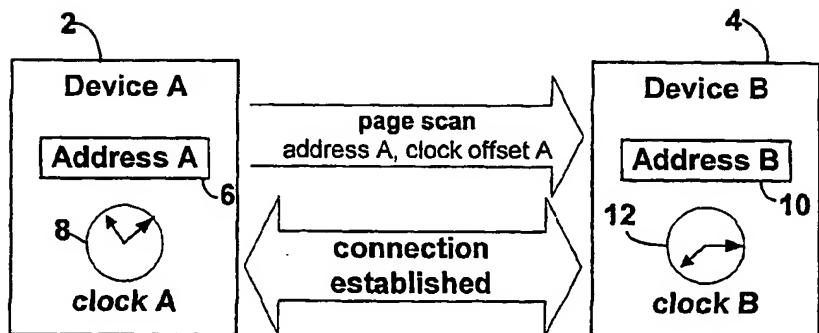


Figure 2

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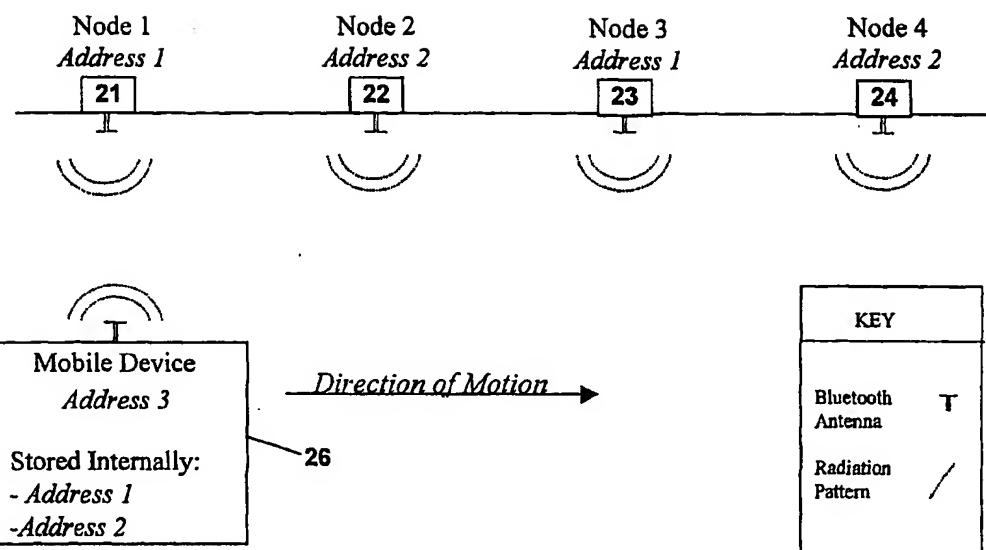


Figure 3

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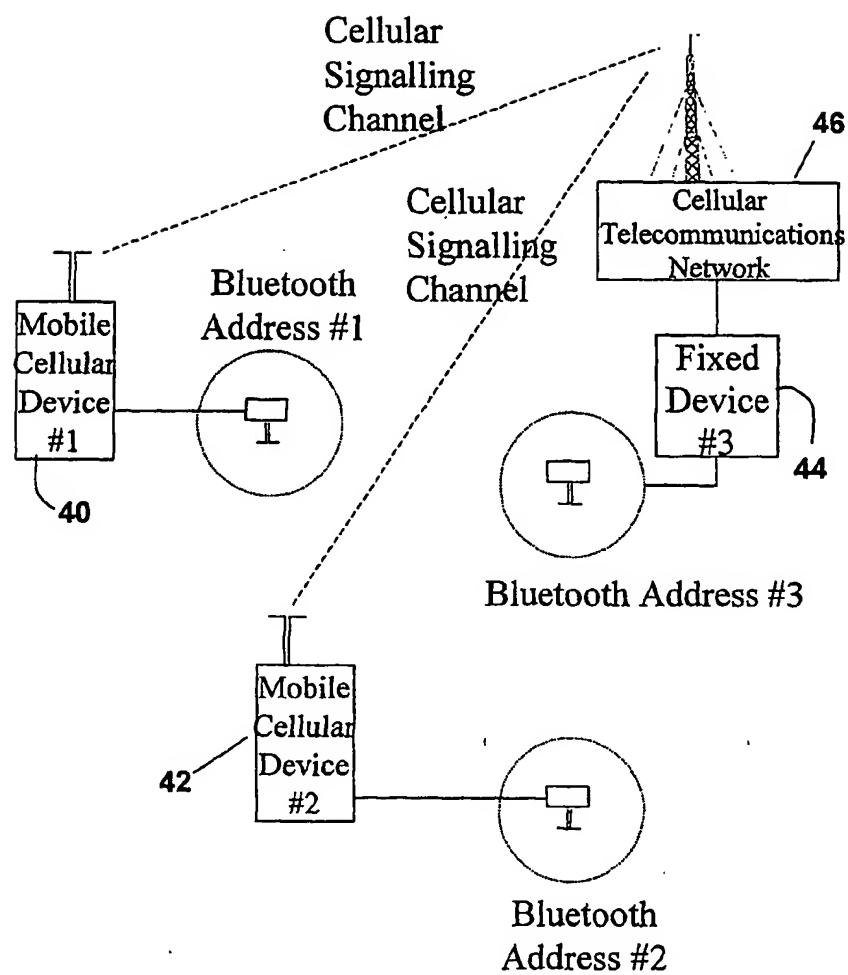
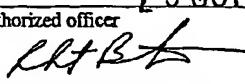


Figure 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU01/01189

A. CLASSIFICATION OF SUBJECT MATTER		
Int. CL ⁷ : H04B 7/26		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) WPAT, INSPEC, INTERNET: BLUETOOTH AND (PICOCELL, PICONET, PICO-CELL)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P, X	WO 01/20940 A1 (NOKIA CORPORATION) 22 March 2001. See whole document	1-23
X	Albrecht M et al, "IP SERVICES OVER BLUETOOTH: LEADING THE WAY TO A NEW MOBILITY", Proceedings 24th Conference On Local Computer Networks. LCN'99, 18-20 October 1999, pages 2-11	1, 23
X	Perkins, C. E, "MOBILE NETWORKING THROUGH MOBILE IP", IEEE Internet Computing, Jan-Feb 1998, Vol. 2 Issue 1, page(s) 58-69	1
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C <input checked="" type="checkbox"/> See patent family annex		
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Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized officer  ROBERT BARTRAM Telephone No : (02) 6283 2215	

INTERNATIONAL SEARCH REPORT

International application No.

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Wu S.F.; Perkins C.; Bhagwat P, "CACHING LOCATION DATA IN MOBILE NETWORKING", Advances in Parallel and Distributed Systems, 1993., Proceedings of the IEEE Workshop on, 6 Oct. 1993, Page(s) 71-76	1
TA	ERICSSON, "BLUETOOTH BEGINNERS GUIDE", Retrieved on 2001-10-16. Retrieved from the Internet : <URL: http://www.ericsson.com/bluetooth/beginners_files/Beginners%20guide.pdf >	1-23

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/AU01/01189

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Patent Document Cited in Search Report	Patent Family Member
WO 01/20940	AU 68608/00

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